Narrative Development in Collaborative Pretend Object Play

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Abstract. We have investigated the experience of individuals at play to better understand how narrative is constructed by collaboration in pretend object play. Our study was conducted with dyads that would play together in two distinct play sessions, with each session being video recorded. Each dyad was shown the video in a retrospective protocol collection. We utilized Grounded Theory as a means of developing and testing hypotheses based on the recorded play session. This process is meant to reveal information about how individual player cognition and interaction develops narrative during pretend play. This paper presents initial findings related to narrative development in collaborative pretend object play with the ambition to use these and future analyses to create intelligent agents capable of pretend play. Present findings demonstrate the construction of narrative and collaborative play is crafted through the making and accepting of play-advancing offers, similar to scene-advancing offers found in improvisational acting.

Keywords: Collaborative environments for interactive storytelling, cognition, play, virtual characters and agents

1 Introduction

The field of interactive narrative has drawn on a variety of real-world sources to inspire story generation. A significant amount of work has been accomplished in modeling narrative conventions, such as Propp's Morphology [8] [11] [12]. Fewer have taken real world examples of narrative construction performance and attempted to translate that into a formal system, and most of those that have, have focused on improv theatre [2] [9] [13] [19] [22] [26]. This approach allows researchers to inform the creation of digital agents capable of constructing narrative with the socio-cognitive processes used in human co-creative narrative settings [9] [14]. One major drawback of such agents informed by improv actors, or similar professionals in a performative field, is that this type of interaction requires expertise. For example, improv actors must learn strategies to successfully cope with the cognitive divergence

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that arises in an improvisational performance [10] [15]. Pretend play stands as a largely unexplored field in terms of interactive narrative that shares many features with improv theatre, in that it is highly improvisational and performative, while not requiring any expertise [23] [24]. We contend that by studying the socio-cognitive processes of pretend play, we can better inform how to create computational systems that build on this understanding, including digital agents.

We chose to focus on studying pretend object play, that is play in which objects are representative of imagined characters or objects, given the role of toys in instigating creativity and previous work in formalizing pretend object play [24] [25] [27]. As an example of this category of play, one might imagine two children racing toy cars, imagining the toys to be actual cars and constructing a narrative as the "race" goes on. Within such an environment, there is a high degree of agency for both participants, as both have nearly equivalent opportunities at any time to make large changes in the narrative space. We refer to this identical distribution of agency between the parties involved as *symmetry*. This symmetry within a pretend object play session indicates that the process of building a digital play agent requires a deep level of understanding of the processes involved in play. Therefore we have conducted a study designed to reveal the underlying cognition involved in pretend object play with the end goal of creating intelligent agents that have behaviors modeled after our findings.

The symmetry within pretend object play between peers has further impact in terms of the design of any intelligent agent we might build. In the past, interactive narrative artifacts have had great success with unsymmetrical designs in which the human player has very little control over the narrative, such as in Façade [16]. Utilizing such a design allows for a far more coherent, coordinated narrative experience than generally appears in a more symmetrical design. In contrast, improv acting and pretend play are usually highly symmetrical, which gives a player a far more flexible experience. While it is conceivable to imagine a pretend play simulation in which either the human or digital agent has far greater agency and guides the other through play, we choose a symmetric approach as it allows us to formally test our understanding of human socio-cognitive processes during play. Additionally, we can address the coherency of the narrative by limiting the number of play stories our agent considers to only the most common ones generated utilizing crowd sourcing [20].

The work presented in this paper is part of ongoing research into pretend object play within the context of informing interactive narrative practices. In particular, we draw on early results from a series of observational studies that are further discussed in section 3. In Section 4 we summarize our use of Grounded Theory, and the generated coding scheme. Lastly, Section 5 discusses remaining open questions and our planned future work.

2. Related Work

The majority of agents capable of creative collaboration have come from the study of music improvisation [4] [7] [18]. These agents are capable negotiating with other agents, and humans, but only in controlled environments, and given specific means of negotiation [6]. Theatrical improvisation differs from the musical improvisation, as theatre offers much less underlying structure than music. Sociolinguistic studies of theatrical improvisation have found that all of a theatrical improviser's actions and dialogue are generated and presented within the performance as offers [22]. Magerko et al's The Digital Improv Project employs the concepts of offers, iconicity, and shared mental model negotiation in order to create agents capable of playing improv games, such as *Three Line Scene* and *Party Quirks* [2] [15]. These agents demonstrate a capacity for creative collaboration to build an artifact, either a piece of music or performance, but fail to address many of the larger problems involved in creating an agent capable of such an open ended practice as pretend object play, as they are locked into a specific improv game.

Formal studies of play have revealed its importance for development, in terms of cognition, communication, and emotion modeling, but have made far fewer strides in representing the socio-cognitive processes involved in playing [3] [19] [21]. Research has shown that, as with improvisation, participants of pretend play draw on a variety of sources from multiple domains to co-construct experiences [2] [7] [17]. Sutton-Smith has argued the next step to understanding play will be the development of detailed processual accounts of play [21]. Zook et al previously presented a formal computational model of pretend object play, but focused almost entirely on the process of mapping real objects to pretend objects, leaving interactions between pretend agents as future work [27]. Processual accounts must involve the cognitive, social, and affective processes involved in pretend play between agents, exactly the processes our research has begun to shed light on.

Research into creating agents capable of open-ended pretend play has been up to this point severely lacking. Some researchers in the field of social robotics have begun to look into how robots can interact with humans in socially appropriate and meaningful ways, but this work remains outside the field of play research [1]. We hope in our research to address two major points, how our work in modeling improvisational theatre relates to modeling pretend object play, and the additional concepts required in order for an agent to successfully engage in cooperatively building a narrative with a human through pretend object play.

3 Study Design

In order to create an agent capable of engaging in pretend object play with a human, we first need to determine how two humans engage in naturalistic pretend object play. Based on our previous work with improvisational actors, we hypothesized that pretend object play would follow a similar structure, in terms of its reliance on the offer as the primary unit and depending heavily on negotiation of shared mental models. Improv actors make use of "offers" as a means of forwarding the scene or suggesting what next to do, by making explicit or implicit suggestions, and we hypothesized they would be similarly utilized in play. For example, one might imagine playing toy cars with someone, and suggesting that the two cars race, that would constitute an offer. To test this hypothesis we conducted a series of observational studies of twenty-two adult dyads, as they played on a physical play-mat with toys. The research participants were recruited from a pool of students eighteen years and older.

The studies all took place over a large play-mat spread across three average sized tables. The tables additionally held two boxes, one of primary-colored foam blocks, and the second a collection of toys. We prepared the participants for creative improvisation by employing theatrical warm-up exercises focused on energy and creativity. Besides preparing the participants for improvisation, the activities also allowed them to interact with the objects and playmat, as a means of familiarizing the individuals with these components of the study.

From this point, participants were asked to take part in two five-minute play sessions making use of the provided play-mat and toys. All interactions were video recorded. After each section, we made use of retrospective protocol collection, showing the participants their filmed play session with an interviewer prompting them to continuously comment on what they recalled about their thought process and motivation during what was transpiring on the recording. We also filmed these interviews and made use of them in our analysis, primarily as a means of checking the results of utilizing Grounded Theory.

In order to understand prototypical play scenarios, we made use of an Amazon Mechanical Turk study in order to crowd source the most common play scenarios given the toys available [20]. We found the top four most common play scenarios to be "Drag Race", "Car-Smash-A-Thon", "Monsters Attack", and "Zoo Visit". For the first five-minute play session, we randomly selected one of these scenarios and instructed the dyad to structure their play to match the given scenario. For the second play session, we gave each individual a different and previously unseen scenario, and expressly asked him or her not to reveal it to his or her partner in any way while also playing together. This allowed us to gain information about how our agent might blend two different

scenarios together, as the dyad had to creatively find a way to incorporate both their play scenarios into a single session.

In response to the data we had collected thus far, halfway through the study we decided to make two changes to the study protocol. We introduced an explicit "setup period" during each play session, in which the participants could setup the scene of their play session without fear of using up their allotted play time. We were previously consistently seeing, unprompted, a setup period before participants would begin to play and wanted to determine the results of expressively defining such a period. Secondly, we decided to ask our participants to limit their verbal communication to sounds or short utterances, as this would be the maximum capability of our play agent. We hoped to therefore determine how restraining communication would impact the play and narrative development, in terms of creativity and collaboration.

4 Analysis

Once we had completed all twenty-one studies, we began the process of analyzing the filmed play sessions and post-play interviews. To ensure we were not biased toward analyzing the play sessions in terms of our previous work with improv actors we chose to make use of Grounded Theory as a means of generating hypotheses [5]. Furthermore we made use of an analysis team largely composed of individuals unfamiliar with our previous improv work. This team generated a coding scheme naturally via watching and discussing the videos, and constantly iterated upon it throughout the process. At this time we have nearly completed the analysis of all videos, though we still require additional reviews to ensure the highest possible consistency, we can begin to discuss results.

At present through a process of constant iteration we have settled on a coding scheme split into five main categories: People, Object, Communication, Play Action, and Non-Diegetic Activities. These categories have proved sufficient in capturing the entirety of each play session. We utilize the People category as a means of tracking specific participant actions during a play session. Object encapsulates sub-categories and codes to track object selection, image scheme use, object type, and object manipulation. These largely all served to track what objects appeared most in which play scenarios and how they were made use of, largely within the setup portion of each play session.

Communication and Play Action together encapsulate the majority of the actual play part of each play session. In particular, we made use of codes within the Communication category as a means of determining how and to what purpose the participants attempted communication during the play session, for example whether communication was verbal or gestural, and if it were for the purpose of requesting clarification or paired with a play action.

The Play Action category similarly deals with player actions, specifically non-verbal sounds and actions within the play sphere. These actions can be either individual or collaborative and either be iconic or unexpected. We judged iconic actions purely subjectively based on the coding team's own cultural knowledge of the play scenarios. For example, an iconic individual action for "Zoo Visit" might include driving to the zoo or moving between different animal's enclosures.

The Play Action category also includes the concept of offers, or attempts by one player to interact with another player, and codes representing the second player's potential reactions to said offers. The introduction of this code arose naturally as a means of capturing how individuals began collaboratively playing. As an example, in sessions such as "Monsters Attack", we frequently saw one participant attempt to draw the other participant into a "fight" by attacking their peer's monster or toy, leading to a period of intense interaction that also served to forward the play narrative. Non-Diegetic Activities includes only a 0-10 Creativity scale for subjectively judging the creativity of both the setup and play sections of each play session. We include these codes as a means of expressing a quantifiable number to each play session's creativity in order to establish correlation between creativity and other facets of a play session.

5 Discussion and Future Work

The work of analyzing the play studies, while not complete, still presents interesting discussion points at this early stage. In particular the coding results at the present time show strong parallels between our previous work with improv actors and collaborative pretend object play, in particular when it comes to the atomic unit of the offer, present in improv as a means of developing the scene. In 79% of the recorded play sessions, we found at least one clear instance of an offer that in every case preceded collaborative play. Additionally within the 21% of sessions that displayed no offer, 75% had no recorded instance of collaborative play. We contend that this indicates the use of offers as a means of establishing collaborative play and forwarding the play narrative.

Shared mental models arose as a theory to explain how individuals in improv collaborate together by constructing a shared understanding about the content of a scene [15]. With a shared mental model, improv actors can deal with discrepancies between their own model and those of their fellow actors via attempting to repair the shared mental model either implicitly or explicitly [10] [15]. Similarly, we saw evidence for shared mental models within the play session in terms of participant's responses their peer's offers. The introduction of an offer, by its nature of proposing a new direction or development to collaborate towards can create a discrepancy within an individual's mental

model in the scene and we identified four main strategies for how participants dealt with this divergence. The first was to simply ignore the offer, essentially a participant refusing to alter their shared mental model. All the other responses in some way addressed the offer, either through passively accepting it, imitating the offer, or creating a new offer based on the previous one. In each play session where we recorded an offer, we recorded one of these responses.

At present, the work of building up a formal, computational model of play to inform the creation of our agent remains incomplete, along with actually completing the agent. However, we have begun significant work on an environment in which to test the agent through interaction with other human agents. In particular we have developed a virtual 3D scene containing representations of the play-mat and each of the toys present within the play study sessions. We strove to duplicate as close as possible the environment within the play studies in order to make drawing comparisons between the two as simple as possible.

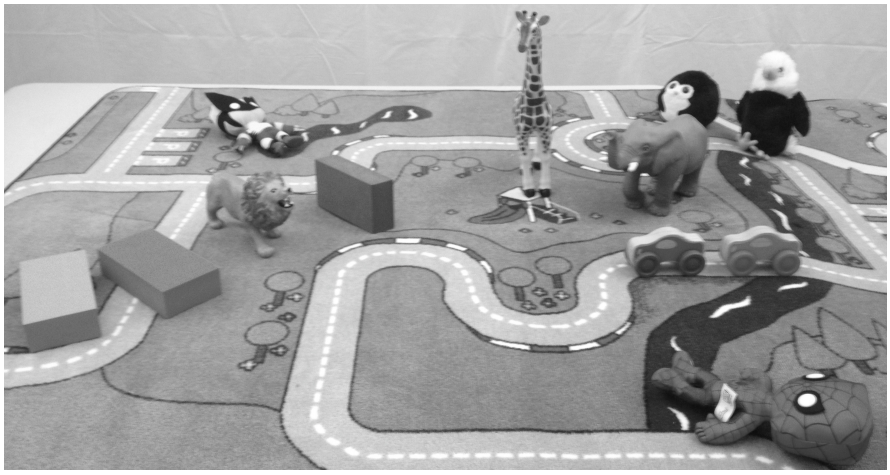

Fig. 1. The physical play-mat utilized within the studies with a selection of toys.

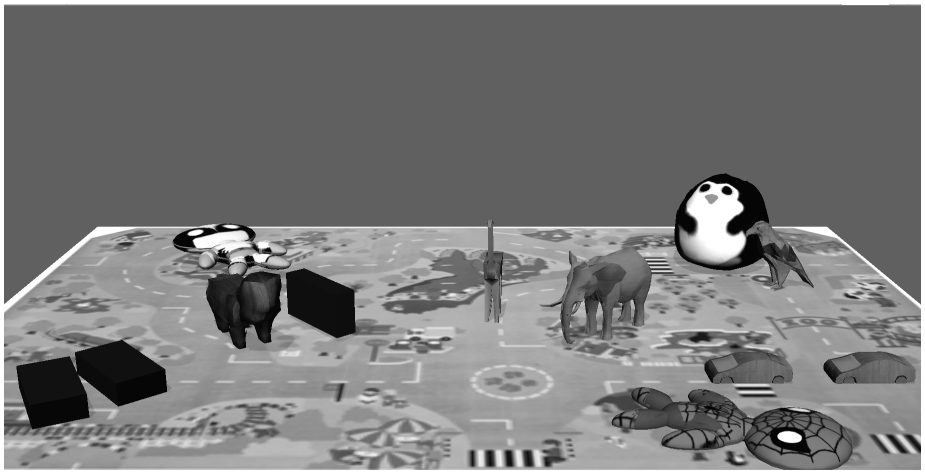

Fig. 2. The virtual play-mat with a selection of virtual toys.

Human individuals interact with the virtual environment via two avatar hands, complete with fingers that move based on physical movements made by the user read in through the Microsoft Kinect. Utilizing the SimpleOpenNI and FingerTracker libraries for Processing, along with in-house algorithms, we've been able to track hand rotations along two axes, determine when hands are open or closed, and reliably track fingers allowing users to pick up and manipulate the virtual objects. In so doing we can present a fairly naturalistic experience that corresponds to the actual movements a user would undertake during physical pretend object play. This is important, as the virtual agent cannot interact with objects in the physical world, meaning that any interaction with a human agent must be within the virtual environment.

Future work will focus on a deeper understanding and formalization of pretend object play (e.g. how do novices construct a narrative). One of the key ways of testing our understand will be through the creation and subsequent analyzing of the collaborative pretend play agent. As a means of validating such tests, we'll need to continue work on the virtual environment to ensure we're specifically testing the prowess of the agent, not the environment. The end result will be a cognitive model of human pretend object play and an agent that incorporates said model capable of collaboratively constructing a variety of different narratives with a human partner.

6 Conclusion

We contend that the work presented in this paper represents a promising new look at informing interactive narrative development through the study of pre-

tend object play. The preliminary results of our initial study of dyads engaged in pretend object play demonstrates striking parallels between the processes human agents utilize in this style of play and improv theatre. These similarities justify approaching the study of pretend object play, which largely lacks processual accounts, under the lens of previous research into the processes that compose improv theatre. We intend to continue our analysis of our original study and to engage in further studies to flesh out our understanding of pretend object play. We intend to formally test our model of pretend play via the creation of a digital agent capable of constructing narrative by engaging in this style of play with a human or other digital agent.

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